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SUBJECT: Skylab-2 Launch Opportunities and Time in Coelliptic Orbit - Case 610

DATE: March 31, 1970

FROM: W. L. Austin

MEMORANDUM FOR FILE

I. Introduction

[redacted]

The purpose of this memorandum is to discuss Skylab-2 (SL-2) launch opportunities and the time spent in coelliptic orbit with respect to MSC's latest rendezvous profile. A summary of the sequence of events and orbits for M=4, 5, 6, 12, 13, 14, 15 and 16 rendezvous schemes is presented in Table 1. M=16 was chosen as the upper bound for the slow rendezvous, as the time to rendezvous for M numbers larger than 16 will exceed 24 hours. SL-2 launch opportunities and time in coelliptic orbit are discussed in that order in the succeeding sections.

II. Skylab-2 Launch Opportunities

Figure 1 shows the SL-2 launch opportunities for a period of 6 days after the Skylab-1 (SL-1) launch beginning with day 1. Three SL-1 altitudes are plotted, 225, 235 and 245 nm. The baselined SL-1 altitude is 235 nm. The 225 and 245 nm altitudes are shown for comparison purposes only.

The SL-2 payload allotted for yaw steering is 700 lbs which results in a launch window of approximately 15.5 minutes duration (assuming variable launch azimuth). The center of the window corresponds to an in-plane (no yaw steering) SL-2 CSM launch. The time of the center of the launch window is shown for each day in terms of the number of hours from SL-1 launch.

SL-1/2 insertion phase angle capabilities for the various M numbers are shown as bands of parallel lines. The phase angle ranges shown are consistent with the sequence of events and orbits shown in Table 1. The following analysis is for the baselined 235 nm SL-1 altitude.

From Figure 1 there are a variety of launch opportunities for each day excluding day 5 for which there are no opportunities. On days 1, 3, 4 and 6, M=5, 14, 16 and 4 respectively are the best opportunities as they contain the center-of-the-window and are at least as long, or longer than, the other opportunities. For day 2, M=12 is the best opportunity as it is the longest and closest to the center-of-the-window. To summarize, there is a fast opportunity on days 1 and 6, slow opportunities on days 2, 3 and 4. There is no opportunity on day 5, assuming M=16 is the longest allowed.

Code - None
Pages - 5

III. Time in Coelliptic Orbit

Figure 2 shows the time SL-2 would spend in coelliptic orbit for various times of SL-1 launch (the beginning, mid-point and end of its baselined launch window) for 6 days after the SL-1 launch, beginning with day 1. The time in coelliptic orbit is shown for the 235 nm SL-1 altitude. The differences for the 225 and 245 nm altitudes are so slight they would not show up in the figure.

The figures were computed on the basis of the same terminal phase geometry and lighting as currently used by MSC. TPI is performed when the elevation angle is 28 degrees, the transfer angle from TPI to TPF is 130 degrees, and TPI occurs 20 minutes prior to sunrise.

MSC personnel have informally stated that the minimum acceptable time SL-2 must spend in the coelliptic orbit is 30 minutes. As can be seen in Figure 2, launching the SL-1 up to 3:45 p.m. always results in a coelliptic orbit time greater than 30 minutes. Launch just after 3:45 p.m. results in the possibility of SL-2 spending slightly less than 30 minutes in the coelliptic orbit. Finally, for a 4:30 p.m. SL-1 launch, any SL-2 launch prior to day 3 will result in a time in coelliptic orbit of just less than 30 minutes.

IV. Summary

SL-2 launch opportunities exist on 5 of the first 6 days after SL-1 launch beginning with day 1. There are no day 5 launch opportunities subject to the M=16 limitation. The best opportunities on days 1 through 4 are M=5, M=12, M=14 and M=16 respectively. On day 6, M=4 is the best opportunity.

For an SL-1 launch after 3:45 p.m., the 30-minute minimum time in coelliptic orbit constraint is not quite met on days 1 and 2, if SL-2 is launched late in its window. For a 4:30 p.m. launch the coelliptic time constraint is not quite met until day 3. In the worst case, however, the time in coelliptic orbit is only 1.8 minutes short of the 30-minute minimum.

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Attachments

TABLE 1. SEQUENCE OF EVENTS AND ORBITS FOR M=4, 5, 6, 12, 13, 14, 15, 16 RENDEZVOUS

Maneuver	No. of Orbits								Orbits	Remarks
	M=4	M=5	M=6	M=12	M=13	M=14	M=15	M=16		
Insertion	1/2	1-1/2	2-1/2	3-1/2	3-1/2	3-1/2	3-1/2	3-1/2	81x120	Perigee insertion
NC1	1-1/2	1-1/2	1-1/2	6-1/2	7-1/2	8-1/2	9-1/2	10-1/2	(120x95) to (120x215)	NC1 Δv is constrained to >25 fps
NC2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	(215x95) to (215x215)	
NCC	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	215x225	ΔR = 20 nm
NSR	<1/2	<1/2	<1/2	<1/2	<1/2	<1/2	<1/2	<1/2	225x225	Δh = 10 nm
TPI	≈130/360	≈130/360	≈130/360	≈130/360	≈130/360	≈130/360	≈130/360	≈130/360	225x237.2	Transfer angle = 130°
TPF									235x235	Skylab-1 Altitude

Additional Remarks:

(1) NC1 is performed at 120 nm; opposite pericentron may range from 95 to 215 nm.

(2) NC2 altitude may range from 95 to 215 nm; however, the opposite pericentron must be 215 nm.

(3) TPI occurs 20.0 min prior to sunrise.

(4) TPF occurs 13.59 min past sunrise.

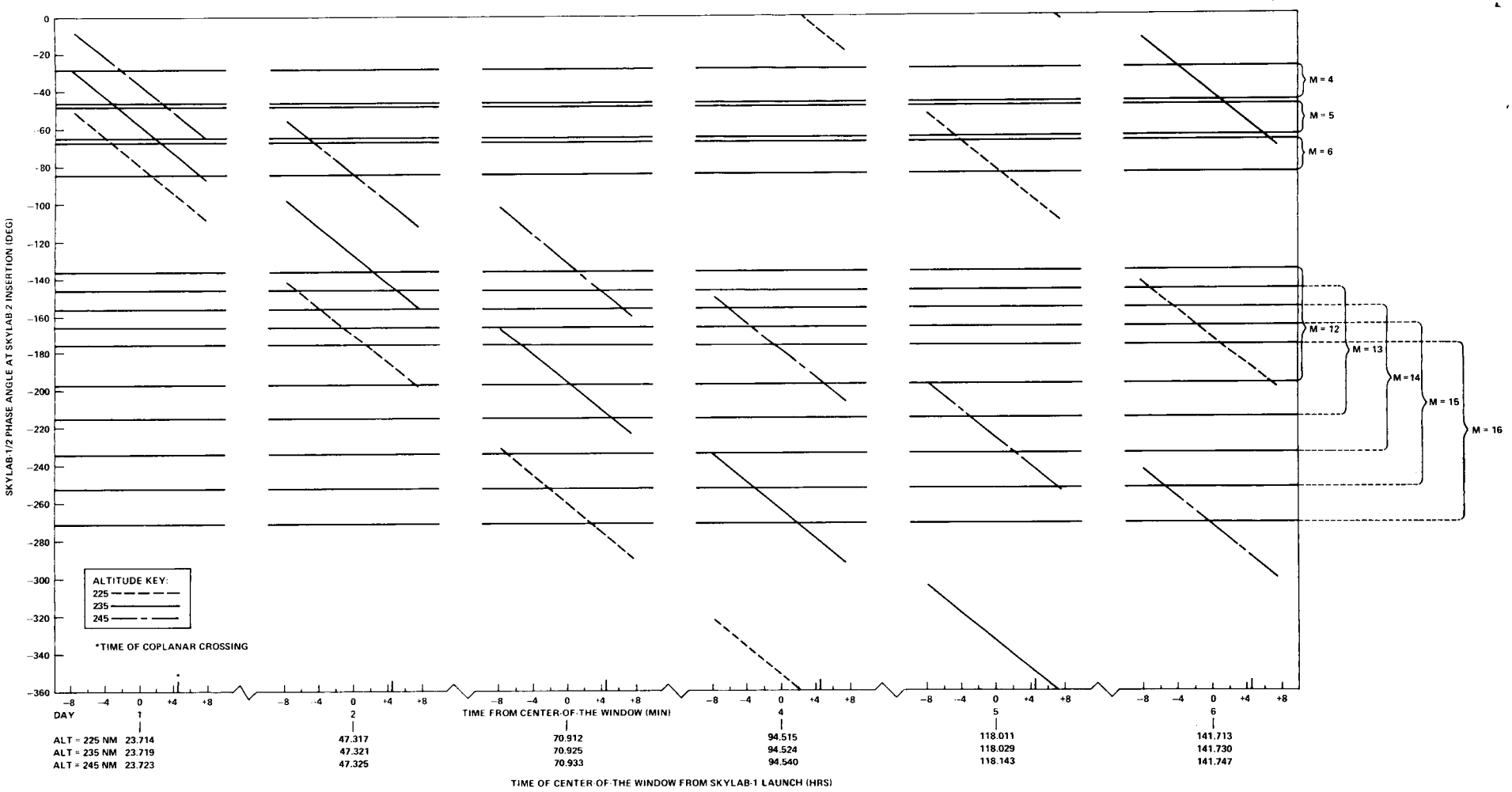

FIGURE 1. SKYLAB-2 LAUNCH OPPORTUNITIES FOR 5 DAYS AFTER SKYLAB-1 LAUNCH – BEGINNING WITH DAY 1
(INCLINATION = 50 DEG.)

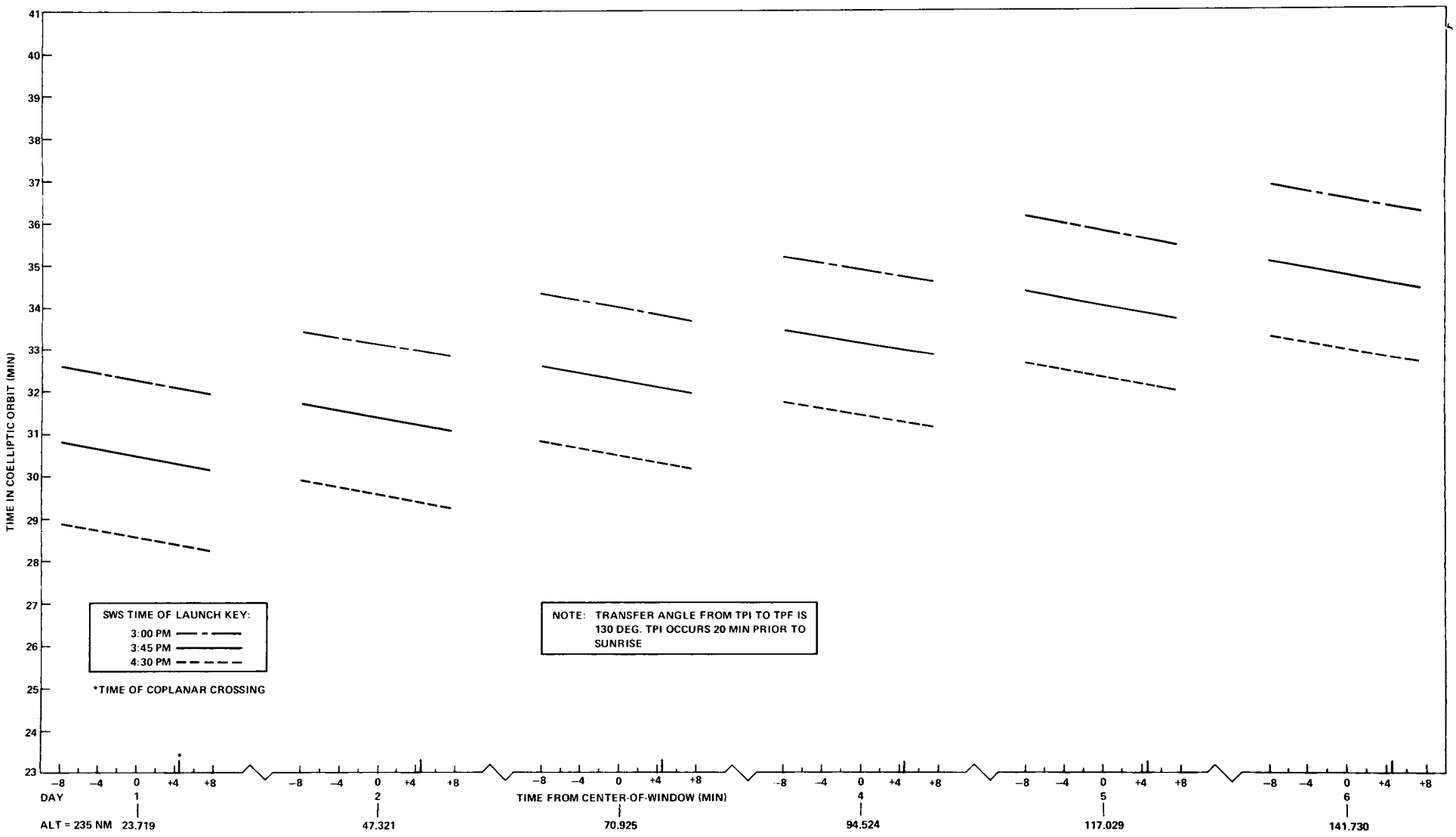

FIGURE 2. SKYLAB-2 TIME IN COELLIPTIC ORBIT FOR VARIOUS TIMES OF SKYLAB-1 LAUNCH ON JULY 15, 1972

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